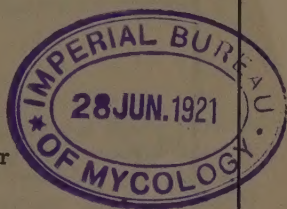


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Spraying Practices for Fruit Diseases

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Special Spraying Practices for Fruit Diseases

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INTRODUCTION

In the prevention or control of the diseases of fruits various practices must be put into operation. The grower should bear in mind that spraying is not a panacea for all troubles, but only one of the important measures for use against certain fungous diseases and insect pests. Due consideration should also be given to sanitary measures, cultural practices, the control of water supply, harvesting and storage practices and the selection of resistant varieties. In the following pages only those fruit diseases of our state for which spraying is an important practice will be listed. For a full understanding of the symptoms, effects and preventative or control measures for fruit diseases the grower would do well to consult a descriptive manual.*

HOW TO SPRAY

Success in preventing or controlling fungous diseases by spraying depends in a large measure upon the following:

1. The use of a spraying apparatus suited to the crop to be protected or to the trouble to be prevented.
2. The application of the spray mixture at the right time.
3. The selection and use of the proper fungicide.
4. Thoroughness of application.
5. The use of a high pressure whenever possible.

FUNGICIDES

Chemical substances which check or prevent the growth of fungi and so protect plants from infection when applied to their surfaces are called fungicides. They are in reality fungous poisons. While many substances have been tried a relatively small number have come into general use. The most important fungicides used in spraying are lime-sulphur and Bordeaux mixture, the former being also valuable as an insecticide, and the latter an insect repellent. A number of other fungicides find a somewhat restricted use, but the formulæ for only those referred to in this bulletin will be included.

*Hessler, L. R. and Whetzel, H. H. Manual of Fruit Diseases p. 1-462. Macmillan & Co., New York, 1917.

FORMULÆ FOR SPRAY MIXTURES

A. Lime-Sulphur.

Sulphur	1 to 1½ pounds
Fresh stone lime	¾ pound
Water	½ gallon

Slake the lime in the cooker. Add the sulphur and the water. Boil briskly till the sulphur is dissolved (about 45 minutes) stirring continuously and keeping the cooker covered. As it boils down keep adding water. When finished let settle. Use only the clear liquid, which may be stored if kept from the air. Prepared in this way lime-sulphur should have a hydrometer reading of about 26° Beaume, somewhat weaker than the factory-made product. Write for Bulletin 64, Washington Experiment Station.

For use, any concentrated lime-sulphur, either home made or commercial, may be diluted according to the following table:

Table for Diluting Lime-Sulphur

Hydrometer test of concentrate		To make 100 gal. of spray use:				
		For dormant spray	For summer spray			
		1 lb. sulphur in 6 gal. Beaume 3.0 Sp. Gr. 1.020	1 to 25 Beaume 1.6° Sp. Gr. 1.011	1 to 30 Beaume 1.28° Sp. Gr. 1.0094	1 to 40 Beaume 1° Sp. Gr. 1.0071	1 to 50 Beaume 0.82° Sp. Gr. 1.0057
Degrees Beaume	Specific Gravity					
34	1.3051	6.7 gal.	3.6 gal.	3.1 gal.	2.3 gal.	1.9 gal.
33	1.2901	6.9 "	3.8 "	3.2 "	2.4 "	2.0 "
32	1.2778	7.2 "	4.0 "	3.4 "	2.5 "	2.0 "
31	1.2677	7.5 "	4.2 "	3.5 "	2.6 "	2.1 "
30	1.2569	7.8 "	4.4 "	3.7 "	2.7 "	2.2 "
29	1.2462	8.2 "	4.6 "	3.8 "	2.9 "	2.3 "
28	1.2357	8.5 "	4.8 "	4.0 "	3.0 "	2.4 "
27	1.2254	9.0 "	5.0 "	4.1 "	3.1 "	2.5 "
26	1.2153	9.4 "	5.2 "	4.3 "	3.3 "	2.6 "
25	1.2053	9.8 "	5.4 "	4.6 "	3.4 "	2.8 "
24	1.1955	10.2 "	5.7 "	4.8 "	3.6 "	2.9 "
20	1.1578	12.3 "	7.1 "	6.3 "	4.5 "	3.6 "
16	1.1224	16.2 "	9.5 "	7.6 "	5.7 "	4.7 "

Example: To make summer spray No. 2 from 33° lime-sulphur use 3.2 gallons concentrate to 100 gallon tank, i. e., "1 to 30."

B. Self-Boiled Lime-Sulphur.

Lime	8 or 10 pounds
Sulphur	8 or 10 pounds
Water	50 gallons

These are designated as the 8-8-50 or the 10-10-50 formulæ. This spray can be used on trees like the peach, with tender foliage, without danger of burning, or on apples with little danger of russetting the fruit. None of the lime-sulphur sprays have as high a fungicidal value as Bordeaux except in the treatment of mildews.

The following method of preparation is quoted from U. S. Dept. Agric. Bureau of Plant Ind. Bul. 174:15-16, 1910:

"The mixture was composed of 8 pounds of fresh stone lime and 8 pounds of sulphur (either flowers or flour may be used) to 50 gallons of water. The mixture can best be prepared in rather large quantities say, enough for 200 gallons at a time, making the formula 32 pounds of lime and 32 pounds of sulphur, to be cooked with a small quantity of water (8 or 10 gallons) and then diluted to 200 gallons.

"The lime should be placed in a barrel and enough water poured on to almost cover it. As soon as the lime begins to slake the sulphur should be added after first running it through a sieve to break up the lumps. The mixture should be constantly stirred and more water added as needed to form a thick paste at first and then gradually a thin paste. The lime will supply enough heat to boil the mixture several minutes. As soon as it is well slaked, water should be added to cool the mixture and prevent further cooking. It is then ready to be strained into the spray tank, diluted and applied.

"The stage at which cold water should be poured on to stop the cooking, varies with different limes. Some limes are so sluggish in slaking that it is difficult to obtain enough heat from them to cook the mixture at all, while other limes become intensely hot on slaking and care must be taken not to allow the boiling to proceed too far. If the mixture is allowed to remain hot fifteen or twenty minutes after the slaking is completed, the sulphur gradually goes into solution, combining with the lime to form sulphides, which are injurious to peach foliage. It is therefore very important, especially with hot lime, to cool the mixture quickly by adding a few buckets of water as soon as the lumps of lime have slaked down. The intense heat, violent boiling and constant stirring result in a uniform mixture of finely divided sulphur and lime, with only a very small percentage of the sulphur in solution. The mixture should be stirred to take out the coarse particles of lime, but the sulphur should be carefully worked through a strainer."

C. Bordeaux Mixture.

Copper sulphate (blue stone)	4 pounds
Quick lime	5 pounds
Water	50 gallons

Prepare stock solution of both copper sulphate and lime of such strength that each gallon will contain one or two pounds of these substances. Protect from evaporation or dilution by rains and always stir before using. Dissolve copper sulphate either by suspending in a coarse bag in water or in hot water.

In using the stock solutions measure out the sufficient amount of each and dilute with half the quantity of water in separate vessels (wooden). The two diluted solutions should then be poured together through a copper sieve (about 20 meshes to the inch) to exclude small particles. Bordeaux should always be freshly made each time, as it deteriorates by standing. The mixture may be tested to see that it does not contain an excess of copper. Add a few drops of a 10% solution of potassium ferrocyanide (yellow prussiate of potash). If the drops make a brown precipitate in the Bordeaux, more lime should be added.

Other Bordeaux Mixtures

	(a)	(b)	(c)	(d)	(e)
Copper sulphate ..	1 lb.	2 lb.	2 lb.	3 lb.	6 lb.
Lime	2 lb.	2 lb.	4 lb.	4 lb.	6 lb.
Water	50 gal.	50 gal.	50 gal.	50 gal.	50 gal.

The dilute Bordeaux mixtures up to the 2-4-50 formula are designed for summer sprays on plants like peach and Japanese plums which have a tender foliage. See blight of peach and cherry shot-hole or yellows.

The strong Bordeaux, the 6-6-50 formula, is the strength designed for winter spraying or for late fall applications after the danger of burning of the foliage has passed. It should never be used as a summer spray for fruits. See anthracnose of apple and blight of peach and other stone fruits.

D. Resin Bordeaux.

Bordeaux, any strength	48 gallons
Resin "sticker"	2 gallons

The resin "sticker" is made by melting 5 pounds of resin with one of pint fish oil, cooling slightly and adding one pound of soda or lye while stirring. The mixture should be diluted with 5 gallons of water. The resin "sticker" is used to increase the adhesiveness of Bordeaux and is needed for plants having a very smooth or glaucous surface. See anthracnose of blackberry and raspberry.

E. Burgundy Mixture.

Copper sulphate	2 pounds
Sodium carbonate (sal soda)	3 pounds
Water	100 gallons

Each one of the ingredients should be dissolved separately in water and then diluted to make half of the quantity to be used and the two diluted solutions brought together as in mixing Bordeaux.

This mixture may be used to advantage when it is necessary to avoid the spotting of developing fruit from use of Bordeaux. See anthracnose of blackberry.

F. Ammoniated Copper Carbonate.

Copper carbonate	5 ounces
Ammonia (26° Beaume)	3 pints
Water	50 gallons

Dilute the ammonia to about five times its volume in water and use just enough to dissolve the copper carbonate. The strong solution may then be diluted to the proper volume. Should be used very soon after preparation. This fungicide is not as good as Bordeaux but may be used when the sediments or stains from that fungicide are objectionable, for example, late spraying of small fruits.

G. Iron-Sulphide Mixture*

Iron sulphate (copperas)	4 pounds
Lime-sulphur, 33° Beaume	1 gallon
Water	200 gallons

*See U. S. Dept. Agric. Bul. 120, 15-16, for original method of preparation.

A stock solution of iron-sulphide should be made, using one pound to the gallon. Fill the sprayer tank and when the agitator is running, add the lime-sulphur; then slowly pour in the requisite amount of iron-sulphide. In order to insure complete precipitation of the iron-sulphide a slight excess of lime-sulphur may be used. This is the modified Ballard formula and has been used in various sections of the state. In some cases it has caused injury to the fruit.

Iron-sulphide is a mildew spray and has been recommended especially for apple mildew. It has not been very generally tested for other mildews.

H. Potassium Sulphide.

Potassium sulphide	3 to 5 ounces
Water	10 gallons

Prepared by dissolving the requisite amount of potassium sulphide in the proper quantity of water. Has been quite generally used for gooseberry mildew. It does not seem to be as effective as lime-sulphur for this trouble, but may be used if lime-sulphur shows any injurious effects.

I. Sulphur.

Flowers of sulphur or any brand of finely sublimed sulphur may be used as a dust spray. But little is known concerning the efficiency of sulphur as a dust spray for fruit diseases in the Northwest. Sulphur dust has been recommended especially for grape mildew, and may be tried for other powdery mildews also.

There are various commercial forms of sulphur such as "atomic sulphur," "sulphur paste," etc., which may be used as liquid sprays at the rate of 2 to 6 pounds to 50 gallons of water. These are more valuable in mildew control than for many other types of diseases.

MIXING SPRAYS

The following table shows what sprays can be mixed together and what ones are incompatible. "x" indicates that there

	Lime-sulphur	Bordeaux	Lead arsenate	Nicotine	Soap	Lime	Soda-sulphur	Oil-emulsion	Iron sulphide	Atomic sulphur
Lime-sulphur	o	o	xrs	x	o	u	u	o	u	x
Bordeaux	xrs	x	xf	x	ox	u	o	ox	u	x
Lead arsenate	x	x	xf	xf	s	u	os	xrs	x	x
Nicotine	x	ox	s	x	u	o	xu	xu	x	x
Soap	u	u	ur	o	o	o	uo	o	u	x
Lime	u	u	ur	x	o	o	u	x	u	x
Soda-sulphur	uo	o	os	xu	xu	o	x	x	x	x
Oil-emulsion	o	o	xrs	xu	x	u	xu	x	u	x
Iron sulphide	xu	xu	u	x	x	xu	xu	x	u	x
Atomic sulphur	ux	u	x	x	x	u	xu	x	u	x

is but slight chemical reaction and the sprays can be safely mixed; "o" indicates that there is a reaction which harms or destroys the value of the individual sprays; "r" indicates that the mixture is repellant to the taste of chewing insects and hence the combination is not apt to be so effective as if the arsenical were used alone; "s" indicates that the combination might scorch foliage; "u" indicates that the mixture is unnecessary.

SPRAYING DIRECTIONS FOR THE PRINCIPAL FRUIT DISEASES

POME FRUITS

Apple

Anthraxnose or black spot canker (Ce).*

1. Immediately after the fruit is picked.
 2. Three weeks later if fall rains begin early and the disease is severe.
- Prune out seriously infested small branches and cut out the dead bark from the cankers on the larger limbs.

Powdery Mildew. (A, 1-30; I atomic sulphur or dust; or G.)

1. Just after the petals fall.
 2. Again in connection with the second spraying for codling moth.
- An earlier spraying before the petals unfold is suggested as of probable value. The spraying should be supplemented by the pruning out of seriously infested twigs during the regular pruning operations.

Scab. A, 1-30; C for 1, A, 1-30 for balance; or A, 1-30 for 1, I, (atomic) for balance.)

1. Just before the blossoms open, that is, when the cluster buds have expanded and the petals show pink ("Pink spray.").
2. Again after the petals fall ("Calyx spray.").
3. A third application ten days to two weeks after the second.
4. A fourth spraying may be necessary in regions or seasons having prolonged rains. In Eastern Washington two sprayings will generally be successful, while the humid sections of the west generally require the additional applications.

Pear

Anthraxnose and powdery mildew may be controlled by the same spraying as for apple.

Pear scab is more commonly found on the twigs than in apple and for this reason the first spraying should be made earlier.

Spray as follows: (A, 1-40 or 50.)

1. Just before the buds swell in the spring.
2. Same as the "pink spray" for apples.
3. Same as the "calyx spray" for apples.
4. About two weeks later. Additional sprayings in accordance with local conditions.

*The letters in parenthesis refer to the spray mixtures described in the preceding pages.

STONE FRUITS

Apricot

California blight (See peach.)

Cherry

California blight (Use A 1-40 and see plum and prune for spraying program.)

Brown rot (See plum and prune for spraying program.)

Shot-hole or yellows (Cc; A 1-40; B 10-10-50. All are about equally effective.)

1. Half way between the blossoming period and the maturing of the fruit.
2. Just after the fruit has been picked.
3. About one month after the second spraying.

Peach

Brown rot (Use B, 8-8-50 and see plum and prune for spraying program.)

California blight (See peach for spraying program.)
plications: A, 1-50; C; B, 8-8-50.)

1. About November 1, or as soon after the late fruit has been picked as possible. If one alone is not effective add the following:
2. Two or three weeks after the petals fall.
3. Again after an interval of two or three weeks.
4. If rainy weather favorable to the disease continues, a third spring application may be required.

Leaf curl (A, 3° Beaume or Ce.)

A single application in the spring before the buds begin to swell is effective. Fall spraying with lime-sulphur has also given good results in New York.

Powdery mildew (I, atomic sulphur or other finely divided sulphur or dust; G; or A, 1-50.)

1. Very soon after the petals fall.
2. At intervals thereafter, the number of applications and the intervals to be varied in accordance with the severity of the disease.

Plum and Prune

Brown rot (For blossom blight: A, 1-40 or Cd.)

1. Just before the petals open.
2. Again just after the petals fall if the disease is severe.

Brown rot (For fruit rot: B, 10-10-50; A, 1-40; Cd; or I, atomic sulphur 3-6 lbs. to 50 gallons. If Bordeaux is used add 2 lbs. of resin-fish-oil soap to each 50 gallons.)

1. About 3 or 4 weeks after the petals fall.
2. Later sprayings at intervals, until fruit is near maturity. The number of applications and the intervals between spraying should be governed by local conditions.

SMALL FRUITS

Blackberry

Anthraxnose (C, 4-5-50 plus 1 lb. resin-fish-oil soap for 1 and E plus 1 lb. of resin-fish-oil soap for 2.)

1. Before the buds open.
2. Two or three weeks after the petals fall.

Leaf spot. (C, 4-5-50.)

1. When the buds are beginning to unfold.
2. At later intervals if necessary. Spraying for anthracnose will control leaf spot.

Cane blight (See raspberry.)

Currant

Anthracnose (C or A, 1-40 or 50.) Practice clean cultivation with destruction of fallen leaves and spray as follows:

1. Just before the leaves appear.
2. Again after the leaves have begun to unfold.
3. Later at intervals of two or three weeks until fruit is two-thirds grown if the disease is severe.

Leaf spot (See gooseberry.)

Powdery mildew (See gooseberry.)

Gooseberry

Powdery mildew (A, 1-40.) Practice careful pruning to thin canes and remove seriously mildewed shoots and spray as follows:

1. When the first leaf clusters have begun to open (leaf clusters $\frac{1}{4}$ to $\frac{1}{2}$ inch long.)
2. Again after an interval of two weeks. Additional sprayings may sometimes be needed but the increased protection is not generally commensurate with the cost.

Leaf spot (C or A, 1-40 the same as for powdery mildew if severe enough to demand treatment.)

Grape

Powdery mildew (I, dust or atomic sulphur; or A, 1-50.)

1. When the blossoms begin to open.
2. Later while grapes are still small, and if possible before mildew shows.

In case the disease was severe the preceding season an earlier treatment should be given when the young shoots are 6 or 8 inches long.

Loganberry

(See blackberry diseases.)

Raspberry

Anthracnose (See blackberry and use same treatment if disease is severe.)

Cane blight (Cut out and burn all diseased canes and try the following applications (C) .)

1. Before growth starts. (6-6-50.)
 2. After the plants are in foliage (4-5-50.)
- Spraying has not given the desired protection.

Leaf spot (See blackberry.)

Spur blight (C, 3-2-50 plus 2 lbs. resin-fish-oil soap.)

1. When canes are 8 to 12 inches high.
2. Again two weeks later.
3. Again after a similar interval.
4. Immediately after picking.

All old fruiting canes should be removed and burned as soon as fruit is harvested.

Strawberry

Leaf spot.

Not generally serious in Washington. Generally cutting and burning of the foliage after harvest is effective. If disease becomes severe use Bordeaux 4-5-50.

Powdery mildew.

Not generally serious. If troublesome use sulphur spray, either liquid or dust.

